TOWARDS AN INTELLIGENT WISDOM BASED SYSTEM FOR ENERGY POLECY STRATEGIES FOR SUSTAINEBLE DEVELOPMENT WITH SPECIAL REFERENCE TO RENEWABLE ENERGY SYSTEM OF INDIA

PhD Synopsis

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INDEX

1. **Introduction…….,……..….....3**

    1.1.1.TABLE1: Growth of Installed Capacity in India……..4

    1.1.2.TABLE: 2All India (Anticipated) Power Supply Position in FY 2016-17…….....4

    1.1.3.Fig.1: Region Wise-Power Deficit (2014-15)……...……5

    1.1.4.Fig.2: Energy and Peak Deficit (yearly)……..5

2. **Literature survey……..…..……9**

3. **Proposed area of work……...……..17**

4. **References…….……19**

INTRODUCTION

The high level of economic growth as seen by the world during fifties created a general confidence in governments for future of industrial growth. It also witnessed an equally rapid increase in energy consumption. The most important aspect of energy has been in its role as a factor for production.

Energy is one of such goods that consumers choose and which influences their standard of living. Energy has its specific linkages to transportation, technological innovations, technological growth and environmental factors leading towards national and global progress. Energy therefore can be considered as the backbone of world economy. It is estimated that almost 80% of energy consumption in the world for mobile as well as stationary applications is met by petroleum and gas while the remaining 20% relies heavily on coal, causing thereby a faster rate of depletion of their limited resources.(1)

After the oil crunch back in 1973 India, along with many other oil importing nations was forced to divert an increased proportion of their resources for importing or developing indigenous energy to keep the economic and other associated systems going, (1) The reasons for 1973 and 1979 oil crises could be attributed to certain policy decisions taken by some oil rich countries rather than any dramatic change in the physical resource reserves.

The experience of some developed as well as developing countries shows that energy conservation and increased energy efficiency can play a crucial role in economic development. Despite high demand and impressive growth rate of installed capacity during the past few decades, the electricity sector in India had an installed capacity of 305.55 GW as of 31 August 2016. Renewable power plants constituted 28% of total installed capacity. The gross electricity generated by utilities is 1,106 TWh and 166 TWh by captive power plants during the 2014–15 fiscal. (57)

The gross electricity generation includes auxiliary power consumption of power generation plants. India became the world's third largest producer of electricity in the year 2013 with 4.8% global share in electricity generation surpassing Japan and Russia.

During the financial year 2014-15, the per capita electricity generation in India was 1,010 kWh with total electricity consumption (utilities and non-utilities) of 938.82 TWh, per capita electricity consumption. Electric energy consumption in agriculture was recorded highest (18.45%) in 2014-15 among all countries. (50, 57)

By the end of calendar year 2015, in spite of poor hydro electricity generation, India has become power additional country with huge power generation capacity wasting for want of electricity demand. It is expected that all the segments of the electricity sector such as fuel suppliers, fuel transporters, electricity generators, electricity transmission companies and distribution companies would be facing severe competition to cut down the prices and

improve their operating efficiency in a final consumer market to meet the demand of power generation.

The power plants installed by the Indian Government are either running on fossil fuel or working on indigenous developed renewable energy forces. The total installed power generation capacity is sum of utility capacity, captive power capacity and other non-utilities.

TABLE1: Growth of Installed Capacity in India

Installed Capacity as on	Thermal (MW)				Nuclear (MW)	Renewable (MW)			Total (MW)	% Growth (on yearly basis)
	Coal	Gas	Diesel	Sub-Total Thermal		Hydel	Other Renewable	Sub-Total Renewable		
31-Dec-1947	756	-	98	854	-	508	-	508	1,362	-
31-Dec-1950	1,004	-	149	1,153	-	560	-	560	1,713	8.59%
31-Mar-1956	1,597	-	228	1,825	-	1,061	-	1,061	2,886	13.04%
31-Mar-1961	2,436	-	300	2,736	-	1,917	-	1,917	4,653	12.25%
31-Mar-1966	4,417	137	352	4,903	-	4,124	-	4,124	9,027	18.80%
31-Mar-1974	8,652	165	241	9,058	640	6,966	-	6,966	16,664	10.58%
31-Mar-1979	14,875	168	164	15,207	640	10,833	-	10,833	26,680	12.02%
31-Mar-1985	26,311	542	177	27,030	1,095	14,460	-	14,460	42,585	9.94%
31-Mar-1990	41,236	2,343	165	43,764	1,565	18,307	-	18,307	63,636	9.89%
31-Mar-1997	54,154	6,562	294	61,010	2,225	21,658	902	22,560	85,795	4.94%
31-Mar-2002	62,131	11,163	1,135	74,429	2,720	26,269	1,628	27,897	105,046	4.49%
31-Mar-2007	71,121	13,692	1,202	86,015	3,900	34,654	7,760	42,414	132,329	5.19%
31-Mar-2012	112,022	18,381	1,200	131,603	4,780	38,990	24,503	63,493	199,877	9.00%
31 Mar 2015	169,118	23,062	1,200	188,898	5,780	41,267	35,777	77,044	271,722	11.98%
31 Mar 2016	185,172	24,508	993	210,675	5,780	42,783	42,727	85,510	301,965	11.13%

Table-1 depicts growth of installed capacity of thermal and renewable energy power generation stating from 1947 till 2016.It clearly shows that there was a further increase in % growth of installed capacity from 1947 till 1974.It relatively declined after that. It is however in the use since 2002.

As of 31 June 2016, the achieved thermal power generation capacity addition excluding renewable power is 82,415 MW against the target of 155,870 MW during the 12th five-year plan which would end on 31 March 2017. (55, 56, 57)

During the fiscal year 2015-16, the electricity generated in utility sector is 1,090.851 billion KWh with a short fall of requirement by 23.557 billion KWh (-2.1%) against the 2.2% deficit anticipated. The peak load met was 148,463 MW with a short fall of requirement by 4,903 MW (-3.3%) against the 2.7% shortfall expected.

In Load Generation Balance Report(LGBR) 2016 report Table2 depicts All India (anticipated) Power Supply Position in FY 2016-17 states that India's Central Electricity Authority anticipated for the 2016–17 fiscal year, a base load energy surplus and peaking surplus to be 1.1% and 2.6% respectively.

TABLE: 2All India (Anticipated) Power Supply Position in FY 2016-17

Region	Energy			Peak Power		
	Requirement (MU)	Availability (MU)	Surplus(+)/Deficit(-)	Demand (MW)	Supply (MW)	Surplus(+)/Deficit(-)
Northern	357,459	351,009	-1.8%	55,800	54,900	-1.6%
Western	379,087	405,370	+6.9%	51,436	56,715	+10.3%
Southern	310,564	320,944	+3.3%	40,145	44,604	-10.0%
Eastern	151,336	135,713	-10.3 %	21,387	22,440	+4.9%
North-Eastern	16,197	14,858	-8.3%	2,801	2,695	-3.8%
All India	***1,214,642***	***1,227,895***	***+1.1%***	***164,377***	***169,403***	***+2.6%***

Report –wise energy and peak deficits for fiscal year (2014-15) was very large in north east region while it was very less in western and eastern region.

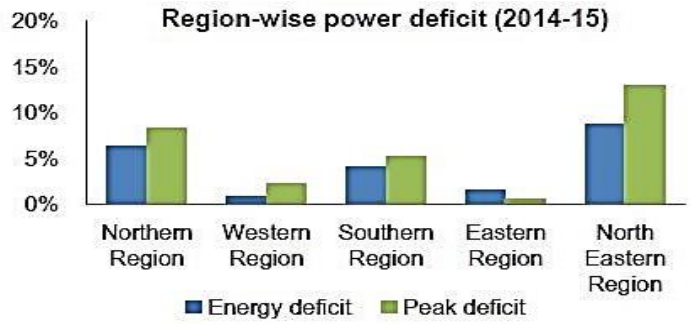


Fig.1: Region Wise-Power Deficit (2014-15)

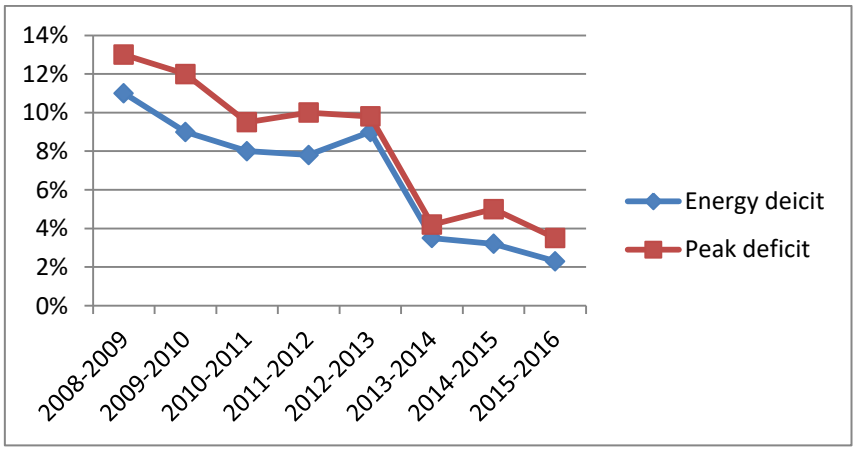


Fig.2: Energy and Peak Deficit (yearly)

Fig-2 depicts the energy and growth deficit from 2008-2009 till 2015-2016.It can be seen that both have witness a decline in their deficit. Energy deficit has seen a genuine decline of 10% from 14% in 2008-2009 to about 4% in 2015-2016.Almost simultaneous is the trend for peak deficit.

Demand carters of the 1.4 billion people in the world who have no access to electricity, India accounts for over 300 million. The International Energy Agency estimates India will add between 600 GW to 1,200 GW of additional new power generation capacity before 2050. This added new capacity is equivalent to the 740 GW of total power generation capacity of European Union (EU-27) in 2005. The technologies and fuel sources that India adopts, as it adds this electricity generation capacity, may make significant impact to global resource usage and environmental issues. (55, 56, 57)

Some 800 million Indians use traditional fuels – fuelwood, agricultural waste and biomass cakes – for cooking and general heating needs. These traditional fuels are burnt in cook stoves, known as *chulah* or *chula* in some parts of India adding more to the level of pollution

Traditional fuel as a source of energy, it's burning releases high levels of smoke, PM10 particulate matter, NOX, SOX, PAHs, polyaromatics, formaldehyde, carbon monoxide and other air pollutants, while it burns. Some reports, including one by the World Health Organisation, claim 300,000 to 400,000 people in India die of indoor air pollution and carbon monoxide poisoning every year because of biomass burning. Traditional fuel burning in conventional cook stoves releases unnecessarily large amounts of pollutants, between 5 and 15 times higher than industrial combustion of coal, thereby affecting outdoor air quality, haze and smog, chronic health problems, damage to forests, ecosystems and global climate. Burning of biomass and firewood will not stop, these reports

claim, unless electricity or clean burning fuel and combustion technologies become reliably available and widely adopted in rural and urban India. The growth of electricity sector in India may help find a sustainable alternative to traditional fuel burning.

Other drivers for India's electricity sector are its rapidly growing economy, rising exports, improving infrastructure and increasing household incomes. Now if we see the today's scenario India is a fastest growing economy and for the fastest development we seek clean, green and non-conventional energy sources to meet the upcoming power challenges, therefore renewable energy sources therefore can play a vital role in this area.

India's renewable energy sector is amongst the world's most active players in renewable energy utilization, especially solar and wind electricity generation. As of June 2016, India had grid connected installed capacity of about 42.85 GW non-conventional renewable technologies-based electricity capacity, about 14.15% of its total; exceeding the capacity of hydroelectric power for the first time in history.(56, 57)

Energy sector can therefore be viewed as a conglomerate of various subsystems within the energy system that are closely connected. Besides, energy itself acts as a part of other bigger systems with incessant mutual interacts of information flows between its components and subcomponents comprising not only of processes, materials and technologies but humans as well.

Rapid industrialization and the ever-changing pattern of energy consumption have gradually caused the energy system to become increasingly complex and full of uncertainties.(1) As an essential factor in overall economic development, energy has become a national issue rather than remain a regional or local one. The interdependencies of the energy sector continually grow to be more involved and simple trend extrapolation for demand and supply forecast ceases to be effective. Among the various alternate paths of development the single course of action eg. single fuel or multi-fuel or mixed-fuel energy strategy that is to be adopted can affect us for 20-25 years due to long life of energy producing establishments, necessitating the need for simulating the after effects of alternative decisions affecting the choice of optimal strategy.(1)

Energy has not only affected the economic development of nations but also attributed to various other aspects at societal level that find its roots towards the quality of life of its people.(3) This has forced policy planners to adopt a more rational approach for futuristic planning of energy, which has increased manifold over the past three decades.(4,5,37,38)

Energy planning and policy analysis has, therefore, emerged as a significant activity in its own right rather than remain a minor extension of the overall developmental planning. And that it is true for renewable energy .Sector for various affects have been made to model. Such scenarios as is evident for the limit. However, there are many complexity involved as there are increasing interacting behaviour between its subsystems and its components.

Energy modelling methodologies can be broadly summed up as process analysis, optimization, econometric models, simulation, inter-industry analysis, system dynamics, and game theory etc.

Although various futurological studies based on quantitative forecasting techniques and qualitative methods using energy have been done. However, both fall prey to assessments towards real world comprehension. The former were approximate due to inherent stochastically errors while the latter failed to respond to the complexities of the ever changing policy issues and their interconnected contextual interactions.

It has been observed that increased energy consumption has resulted in severe negative impacts on the environment. Since wood was unable to meet the fuel demand, the industrial revolution began with the use of fossil fuels eg. coal, petroleum etc. increasing the carbon-di-oxide concentration in the air leading to the beginning of global warming. It, therefore, becomes all the more important for industrialized as well as developing countries to take sufficient care in meeting the requirements of supply and consequential consumption of energy that contributes towards sustainable development

that is, the development that meets the needs of the present without compromising the ability of future generations to meet their own needs.

The need for identifying all such governing parameters in a more logical and rational way is, therefore, imminent while considering energy policy and planning related issue.Considering many uncertainties associated with energy sector particularly with emerging technologies like solar cells, wind mills, Magneto Hydro Dynamic(M H D) etc., resource prices and customer behaviour etc., their inclusion in several stochastic based methodologies have been recently attempted. However, these deterministic models in an attempt to solve the problems of real life systems suffer from the drawback of a larger model size and corresponding computation time which increases exponentially with the number of integer variables. Besides, these fail to incorporate qualitative and value bused parameters into account in its real cognitive sense leading to decisions that are not very close to reality.(7)

Very often the results of a decision analysis are sufficiently insensitive to the exact values of probabilities specified by the decision-maker that his imprecision is unimportant. Further, even if the recommended decision is sensitive to variation in Inputs, it is possible to refine assessments by further modelling until inputs are sufficiently for the correct decision to be clear.(8)

A decision making problem would be therefore useful if one is not forced to use numerical assessments of probabilities and utilities but only if one could describe the values and uncertainties by linguistic expressions- In retreating from precision in the face of overpowering complexities, it is but natural to explore the use of linguistic Variables i.e. variables whose values are not numbers but words or expressions in a natural or artificial language. One of the basic tools for such decision making in a realistic environment is through approximate reasoning in terms of linguistic variables. Such expressions are mostly used in decision making situations even in the presence of deterministic data in real life problems. Further, the problem remains incomplete unless prognosis is followed (9).

The problem of how incoherent judgement in decision analysis ought to be resolved is still unsolved and is the subject of current research interest as in the case of small group dynamic consensus, multi-person multi-option decision making situations and many others. (44, 51, 53, 54, 55, 61), There may be more realistic in case of renewable energy system where accord needs to be built for certain issues among various stake-holders and options and strategies are utilized to resolve conflict among the stake-holders.

Prof.LA.Zadeh has argued strongly that application of systems science to the study of systems involving humans are often unsuccessful(10) because the methodology used demands very high level of precision in measuring variables describing how they are related; Zadeh stresses, that the levels of precision are often neither obtainable nor necessary for an effective systems analysis and, therefore, he introduced the concept of fuzzy set theory and related logics to help study the analysis of human factors of cognitive interaction in the decision making process which is part and parcel of any planning and policy analysis.

Other soft computing methodologies developed later are merely to reinforce his vision towards obtaining a' more realistic down to earth prescription for complex problems that are prone to man-machine-environment interactions not only in renewable energy sectors but Industry and other societal sectors as well.

The reciprocal, coevolving and exponentially growing relationship between technology and information has increased the complexity of everyday life. Adaptation to changing conditions requires more forethought in terms of preparatory activity. Innovative organization, ongoing design and careful implementation are its essential aspects. In the present day situation perhaps the question of organized complexity requires a paradigm shift in evolutionary epistemology that dwells on principle of either maintaining or increasing fitness. The reason for such shift is to understand the inherent characteristics of an efficient controller.

An efficient control problem could be assumed as going beyond achieving regulations through knowledge and seeking optimizing regulation through meta-knowledge or wisdom in order to move towards the determination of the best course of action out of the available ones. It is in this context that modelling and simulation should move from knowledge based intelligent system to wisdom based intelligent system reinforcing the principle of "survival of the wisest".

Whether one focuses on a person, society or global community, it appears our future viability depends more on information processing into knowledge and wisdom rather than mere material processing. It is only with the aid of intelligent knowledge and wisdom based cybernetic systematic applications relying on evolutionary computation techniques that comprehensions of seemingly incomprehensible is possible to a certain extent.

Energy planning at national and global level is, therefore, an essential element in bringing about social change for social process.

Renewable energy system, therefore, can be viewed as a pertinent subject for modelling strategies on complex coevolving issues related to it at policy, planning and strategic level to meet the challenge of sustainable developed.

Literature survey

A brief review of literature reveals that optimization techniques along with other deterministic objective methods have been used in Renewable energy sector for solving various decision making situations. Some of these are stated as follows;

Climaco (11) have developed a multiple objective linear programing (MOLP) model to optimize cost of expansion, reliability and environmental impacts in a power generation expansion problem.

The MOLP model has also been used for the design of a cogeneration system for a process industry by Balestieri and Correia (12), however, the results show that the generated solutions were not optimal yet; they could be used merely to satisfy the prevailing conditions in an effective way.

Optimization techniques have been used in energy sector for solving various decision making situations.

A simple linear programming model to minimise cost function for an energy supply system have been used for a typical Indian village by Joshi (13), however, sustainability has not been included in the cost function thus making the function mono-objective.

Farrag (7) have developed a simulation model for expansion planning for distribution system using separable linear programming technique to give fastest and accurate solution whereas mixed integer linear programming technique, all though very accurate, reliable and efficient required high computation time.

Groscurth (14) have developed an optimization model to minimise primary energy demand, pollution and cost in an energy supply system. They have attempted to use the conventional energy techniques, renewable energy techniques and rational use of energy techniques in the above problems.

Jain and Mora (15) have proposed an approach, referred to as rational use of energy, to overcome the barriers of co-generation in pulp and paper industry. However the system suffers from higher capital investment for its effective implementation which usually is not acceptable to industries in developing nations.

Uncertainty prevalent in a National Energy Modelling System with specific emphasis on petroleum sector have been analysed in quite detail by Baghelai (16).

Vij, Sushil and Premvrat (17) have shown the importance of waste management and detrimental impacts of energy wastage on economy in a multi-sector economy model using physical system theory approach, specifically for petroleum sector .However, they have observed that the usefulness of the model lies only when it is integrated with energy-resource-mix-planning and other simulation models to consider the impacts of various essential and vital dynamic parameters like population, investments, capital, foreign trade etc.

Attempts have been made by Bose and Anandalingman (18) to use multi-objective goal programming model for sustainable urban energy environment management of Delhi.

An engineering econometric model for motor fuel demand in Switzerland was developed by Carlevaro (19).The results emphasizes the need of imposing a carbon tax on emission by way of having a fee bate (fee or rebate) system.

Kaboudan (20) has developed an econometric model to provide projections of energy consumption and forecast maximum electricity demand up to year2010 for Zimbabwe using nonlinear dynamic system of simultaneous equations.

Nagchoudhuri (21) has highlighted the interdependencies between energy and other related economic sectors in a six sector input-output model and has developed a framework that integrates energy sector and other economic sectors.

Linear optimization model of energy as a part of economy has been integrated with a system dynamics model to predict long term changes in a planning situations os a village in China with a population of 800 by Fang Zhen (22).

A system dynamics model of integrated energy system for farming in Bangladesh was developed by Alam, Bala and Haq(3),evaluating its performance with Physical Quality of Life as its index. The developed model requires continuous surveys and upgradations of data for its effective implementation.

Energy economy analysis has also been attempted by Wene (23) by soft linking of macroeconomic and systems engineering approaches. However, the techniques suffer from serious drawbacks of noise and maintain the quality of linking when the system ins passed to a new user.

Sharma (24) simultaneously considers a number of supply options along with demand side options example the availability of draught animal energy. Animal waste and crop residue in relation to the livestock –agriculture subsystem and the tradition use of animal waste as cow dung and manure in comparison with its alternate use as a source of biogas and slurry are some of the other supply options considered in the study.

Eric Herst (25) has summarized the results of integrated resource plan of power of Washington in U.S.A. However, they have observed that loss production opportunities still remain to be analysed.

Groscurth and Kummel (26) have conducted a thermo-economic analysis of national energy system of four nations namely Germany, U.S.A, Netherlands and Japan and found the cost of energy optimization by rising rational use of energy technologies such as heat exchangers, heat pumps etc. including their costs.

A socio-cultural model for household energy consumption has been attempted by Loren (27) to show the effect of cultural diversity on the demand side use of energy. However, the model does not detail in cost benefit analyses and reduction in emission of gases responsible for greenhouse effect.

Easterly, William, and Ross Levine (28) have summarized the public perception about the climate change, cost of reduction in emission social and economic impacts of climate change of a few countries example U.S.A., Japan, China, Russia and developing countries etc. And have suggested policy perspectives for addressing climate change.

An overview of environmental problems of Taiwan economic success and its energy policies pertaining to transportation sector has been discussed in detail by price and Probert (29) with certain recommendations for future transport policies in context of emerging environmental problems.

Johnson (30) has reviewed the effect of price reforms on energy efficiency in China as per the new policy of multi price system. It was observed that although older plants with low efficiency are more profitable at grid level for load assignment problem so far the result in reduction in overall energy efficiency of the country.

Rangan Banerjee and Jyoti K. Parikh (31) have conducted a demand side management (DSM) survey for industry of Maharashtra and suggested policy measures for successfully implementation of DSM plants. Hollander and Schneider (32) have discussed the issues of energy efficiency and elaborated on the reasons for slow progress energy efficiency. Representative load curves (RLC) were used for developing a model for electricity supply planning for the state of Karnataka by Bala Chandra and Vijay Chandru (33) as a trade of between model complexity and accuracy.

Hypothetical energy self-sufficiency from renewable energy technologies by 2100 for Hawaii was suggested by Phillips (34) considering the quality of energy available from renewable energy technologies and cost reduction in renewable energy technologies. A further analysis in the area of renewable energy has been suggested.

Waddle and Perlack (35) discussed the viability of small energy systems using photovoltaic cells for rural electrifications including a dissemination model to allow for a large population of users. A large sample size is suggested to prove that this programme can be implemented on a regional or national level.

Economic growth and industrialization are contingent upon adequate availability of energy. A rigorous and vigilant energy strategy is an essential requirement if industrialization programmes and economic growth are to proceed without obstacles.

This can be well realized provided energy scenario at global and national level in explored.

a) Global Energy Scenario:

World energy consumption is the total energy used by all of human civilization. Typically measured per year, it involves all energy harnessed from every energy source applied towards humanity's endeavours across every single industrial and technological sector, across every country. It does not include energy from food, and the extent to which direct biomass burning has been accounted for is poorly documented. Being the power source metric of civilization, World Energy Consumption has deep implications for humanity's social-economic-political sphere. Institutions such as the International Energy Agency (IEA), the U.S. Energy Information Administration (EIA), and the European Environment Agency record and publish energy data periodically. Improved data and understanding of World Energy Consumption may reveal systemic trends and patterns, which could help frame current energy issues and encourage movement towards collectively useful solutions.

The IEA estimates that, in 2013, total world energy consumption was 9,301 Mtoe, or 3.89×10^{20} joules, equal to an average power consumption of 12.3 Terawatts. From 2000–2012 coal was the source of energy with the largest growth. The use of oil and natural gas also had considerable growth, followed by hydro power and renewable energy. Renewable energy grew at a rate faster than any other time in history during this period, which can possibly be explained by an increase in international investment in renewable energy.

b) National Energy Scenario

India's electricity generation from 1950 to 1985 were very low when compared to developed nations. Since 1990, India has recorded faster growth in electricity generation. India's electricity generation has increased from 179 TW-hr in 1985 to 1,057 TW-hr in 2012. Power generation by coal fired plants and non-conventional renewal energy sources (RES) has mainly contributed to the growth in the total electricity generation whereas the contribution from natural gas, oil and hydro plants has decreased in last four years (2012-2016).Looking at the power supply trends in India, it is evident that there has always been a large gap between the supply and anticipated requirements causing a significant short fall in-power supply, for example in the fiscal year 2015-16, the electricity generated in utility sector is 1,090,851 billion KWh with a short fall of requirement by 23.557 billion KWh (-2.1%) against the 2.2% deficit anticipated(54, 55, 56, 57).

The peak load met was 148,463 MW with a short fall of requirement by 4,903 MW (-3.3%) against the 2.7% deficit anticipated. In Load Generation Balance Report 2016 (LGBR), India's Central Electricity Authority anticipated for the 2016–17 fiscal year, a base load energy surplus and peaking surplus to be 1.1% and 2.6% respectively. Though few regions are expected to face energy shortage, power would be made available adequately from the surplus regions with the higher capacity inter regional transmission links.

India's Ministry of Power launched Deen Dayal Upadhyaya Gram Jyoti Yojana (DDUGJY) as one of its flagship programme in July 2015 with the objective of providing round the clock power to the rural areas. As of 30 September 2015, 97.2% of 597,464 villages in India are electrified. However, because of the lack of availability of data in this direction, the picture of such consumption becomes an abstraction in itself. This may be attributed to the fact that in-spite of the availability of sufficient and accurate data and line loss for energy consumption pattern in individual section (55, 56, 57) and sufficient statement regarding its energy policies specifically for small scale sector which has a vital role to play in the present era of globalization.

Renewable energies sources (RES), always been considered specifically at sectoral levels for energy policy and planning situations towards meeting the aim of sustainable development. Because of many interactions and non-market forces that shape and affect the energy sector of every economy, decision maker in an increasing number of countries have realised that energy sector investment, planning and management should be carried out with in an integrated energy planning framework which helps analyse a whole range of energy policy options over a large period of time. (65)

Energy is so fundamental to modern economy that it is often difficult to declare neat boundaries of planning responsibilities, for example, in case of transportation fuels the boundary between energy policy and transportation policy is not distinct.(64)

c) Modelling techniques;

The study is proposed to be carried out by using methodologies like Hierarchical Structural Models (HSM), Options Field Methodology (OFM), Options Profile Methodology (OPM), Fuzzy Logic and Genetic Algorithm etc. A brief idea of the HSM, OFM and OPM or OFPM is mentioned below;

i. Hierarchical Structural Model;

In Hierarchical structural equation models, all latent variables and indicators vary between units (typically subjects) and are assumed to be independent across units. The latter assumption is violated in multilevel settings where units are nested in clusters, leading to within-cluster dependence, Michael J. Kamfonas(63)

Different approaches to extending structural equation models for such multilevel settings are examined. The most common approach is to formulate separate within-cluster and between-cluster models. An advantage of this set-up is that it allows software for conventional structural equation models to be 'tricked' into estimating the model. However, the standard implementation of this approach does not permit cross-level paths from latent or observed variables at a higher level to latent or observed variables at a lower level, and does not allow for indicators varying at higher levels.

A multilevel regression (or path) model formulation is therefore suggested in which some of the response variables and some of the explanatory variables at the different levels are latent and measured by multiple indicators. HSM is also referred to as Interpretive Structural Modelling.

ii. Options Field Methodology

The "Options Field" methodology for design was invented by the present by Warfield during a project carried out for the Office of Education. In this project it was found that there was a need for a method of design that exhibited a collection of characteristics that no known method of design offered. Specifically, it was intended in John N. Warfield Digital Collection (63) that the method would have all the following characteristics:

1. It should offer a systematic way to portray a finished design
2. It should offer a systematic way to develop the background for doing a design
3. It should be suitable for a group of people to use when working collaboratively, with help from a skilled facilitator and computer programs designed to keep track of the status of the design at all intermediate points in its evolution
4. It should take into account interdependencies among design dimensions
5. It should specifically account for the "Law of Requisite Variety" set forth by Ashby as a necessity to be satisfied in design
6. It should present the design in outline form on one large display, capable of being updated as it is developed
7. It should provide for iteration as required to arrive at a completed design
8. It should be applicable to all kinds of systems, including product

iii. Options Profile Methodology

The Options Profile method of design was created to take advantage of a method called Interpretive Structural Modelling (ISM), also invented by the present author, since ISM can be used to help a group perform several aspects of a design effort. The ISM process is a computer-assisted group process whereby a group is helped by a skilled facilitator (familiar with the ISM process) to create a structure for a set of elements, based upon a selected

relation. The freedom to select a d sired relation in each instance of application is what allows the ISM process to be used several times in the Options Field method, each time with a different type of relation.

An element of complexity with qualitative characteristics sets in most of the systems with man-machine-environment interactions because of the plurality and human centred decision making approaches. This makes deterministic models to miss most of the real world comprehensions in policy, planning and decision making. Soft computing approaches have, therefore, emerged in various fields likes medicines, diagnostics etc.(40,51,53,55,56,60).sage(40) has presented a conceptual overview of contemporary efforts associated with system design for human interactions, emphasizing the integrated efforts of various disciplines viz. cognitive science ,cognitive psychology ,artificial intelligence ,decision science including control theory ,operations research and fuzzy systems for effective methods of information acquisition, representation ,storage and use. Recently attempts have been made to use soft computing techniques in certain specific areas of energy sector besides other areas of planning and decision making. A brief outline of all these is presented below:

Mishra and Panda (41) have used Artificial Neural Network (ANN) for short term (<24 hrs.) load forecasting. However, the optimum learning rate and optimum network structure are yet to be obtained.

A load forecasting Neural Network Model using radial basis function network, work propagation network and recurrent network has been developed by Padmakumari Mohan das(42) for Calicut city and its advantages over conventional progression models have been established.

Chandershekra.(43) have developed an efficient, fast and less memory consuming neuro-expert system for planning and load forecasting distribution systems.

Linguistic variable and fuzzy logic have been used to include uncertainty of customer behaviour for developing a structural model for energy consumption residential sector for long term forecasting of energy demands by Michalik (44)

Although long term distribution demand forecasting methods are generally classified into time series, regression and spatial methods yet Padmakumari(45)have developed a neuro-fuzzy model for long term distribution demand forecasting on the basis of land use. It has been concluded that the model is more suitable because of its special features of nonlinear mapping capabilities.

Slochanal and Kannah(46)have proposed a multilayer feed forward Artificial Neural Network combined with fuzzy set for weather sensitive short term load forecasting.

Gautam,Gupta,Gaur and Mishra (47) have given a fuzzy-set based procedure to select the most satisfy energy project given several alternate energy projects using fuzzy compatibility benchmark of worth, cost and risk to satisfy hierarchical energy policy objectives.

Jain (48) presents a method for the analysis of those systems that are too complex to be analysed using the concept of fuzzy sets to analyse humanistic systems.

Chaudhary and Mujumdar (49) have reported the application of fuzzy set theory in reliability studies of man machine systems. They emphasize the use of their analysis in the study of speech recognition, medical diagnosis, robotic and picture analysis problems.

Negotia and Ralescue (50) have introduced the concept of fuzzy mathematics and explained the relationship of fuzzy set to probabilities, algebraic structures and have dealt at length regarding its application to logics, systems, decision making and clustering.

Yagar(51) in his paper has introduced a methodology in which a decision maker can modulate a decision function by some measure of his satisfaction.

Gibson(52) has proposed a five step model for logical structuring of Systems Engineering.

Agnihotri (53) have applied Interpretive Structural Modelling and Fuzzy set approaches for designing and evaluating handloom policies for India.

In his paper, Rinks (54) has illustrated how mangers using simple Heuristics Decisions may ab able to closely approximate the result of much more powerful optimizing technique for the aggregate planning problems. Linguistics variables have been used to transformed reasonable protocol in to an operational model.

Gaur (55) has synthesized the interacting subsystem models for a small industry to develop a hybrid dynamic expert system to find out industrial dysfunctions using soft computing techniques like dynamic models, fuzzy clustering etc.

Gaur -.(56) have integrated the evolutionary concepts to develop a wisdom based guidance system for small industrial setup in order to analyse and control the system performance in-cooperating important interactive cognitive, human centred and qualitative parameters besides other deterministic variable as well.

Chaturvedi, D.K, Satsangi,P.S and Kalra, P.K(57) have developed a non-linear neural network controller for maintaining a power system in a normal state of operation using a Generalized Neural Network (GNN) that over comes the drawbacks of earlier existing models. They have also used GNN approach for short term load forecasting of Gujrat Electricity Board, and have found that GNN gives a more accurate results of the forecasted values as compared to the other existing models(58).

Chaturvedi, D.K -(59) have used Genatic Algorithm (GA) in a load forecasting system on a long term basis and have compared the result with the available researched data of Central Electricity Authority, Govt. of India, to demonstrate the result of proposed algorithm.

Bhagwandas,D.(61) has used soft computing approaches like ANN etc for simulating the more comprehensive and realistic optimal power flow problems and used some of these techniques to solve the problem of secure economic mission which considering cost, emission and the time overload security as the three objectives. He has also presented a multi objective hybrid evolutionary technique which can optimised the number of objectives simultaneously (62).A new partitioning technique based on electrical distances using ART-2Neural Network has also been used by Bhagwandas Although some attempts towards energy planning have also been done in order to revile simplicity in the complex domain of energy sector using structured models, fuzzy and neuro fuzzy models(41,42,43,44,45,) yet the critically needed task of integrating qualitative and quantitative aspects to move from knowledge to wisdom based systems in order to resolve the system design principles in operational systems engineering practice still remains to be done. Some attempts have been

done in this direction to model systems that are workable in small business for diagnostic purposes (56) yet the energy strategies emphasizing small renewable energy sources remain unexplored.

From the literature survey carried out so far it may be concluded that there is a felt need towards developing integrated national energy policy framework that specially emphasizes on strategies for renewable energy policy for sustainable growth in the present era of globalization and information boom.

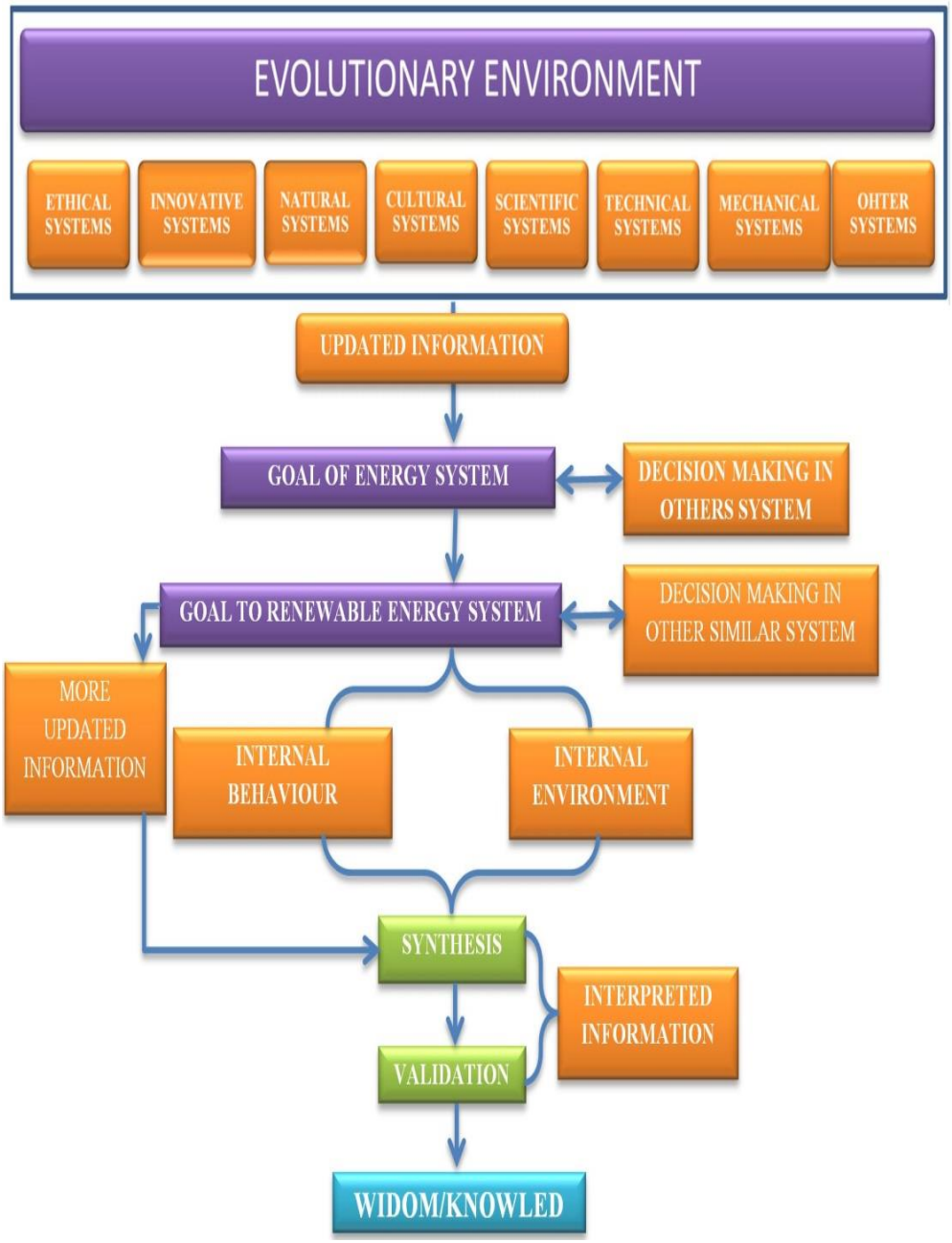
In view of the above facts it is meaningful to explore certain aspects of the vast expense of modelling intelligent wisdom based system for energy policy designing, planning and implementation with an emphasises on renewable energy sector using soft computing approaches to achieve sustainable development of energy and other testing systems.

PROPOSED AREA OF WORK

It is therefore, proposed to develop a wisdom based system for renewable energy policy, strategy with specific reference to renewable energy system of India in order to achieve sustainable development by using soft computing techniques.

The study is proposed to be carried out by using methodologies like Hierarchical Structural Models (HSM), Options Field Methodology (OFM), Options Profile Methodology (OPM), Fuzzy Logic and Genetic Algorithm in the following steps:

Generalized conceptual flow for developing a Wisdom Base



1. To identify descriptive renewable energy policy elements with special emphasises to renewable energy sector.
2. To develop integrated descriptive Hierarchical renewable energy policy structure to get some inside into the complex nature of the system.
3. Once the complexity of the system is captured through such models it becomes feasible to achieve the goal by designing different policy strategies.
4. To select a logical designed policy strategy on the basis of certain multi-objective and multi-criteria energy options.
5. To extract inherent causality for the chosen strategy in order to seek knowledge towards attaining the relevant objective.
6. To develop a model framework that integrates other soft computing techniques in order to move from the area of knowledge to wisdom to achieve even higher degree of "satisficing" solution with respect to the objective of sustainable development of the system.
7. The developed system model is proposed to be validated against responsive criteria.

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